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ABSTRACT

NCR (National Cash Register) Corporation is pursuing opportunities to make their point of sale (POS) terminals easy to use and easy to learn. To approach the goal of making the technology invisible to the user, NCR has developed an adaptive expert prototype system for a department store POS operation. The structure for the adaptive system, the Retail User Assistant (RUA), is a software platform that observes the operator's actions with hardware and software, evaluates the operator's effectiveness, communicates with the user to provide guidance and training, and adapts itself to compensate for changes in the user's knowledge level. NCR has explored the use of text, graphics, and video to communicate with the POS operator. The development of the visual communication (user interface) for the prototype is discussed, through the design phases of analysis, concept development, prototype, validation, and implementation. Considerable work was done clarifying the visual cues for the operator. Lessons learned in the development process were applied to the RUA to reduce the amount of text and refine the icons used. The verdict is still out on the system for retail use, largely because the cost remains prohibitive. (SLD)

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Visual Cues for an Adaptive Expert System

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by
Helen B. Miller

NCR Corporation, a subsidiary of AT&T, is pursuing opportunities to make their Point of Sale (POS) terminals easy to use and easy to learn. In a highly competitive retail supplier market, NCR recognizes the need to help their customers reduce the cost of operator training and avoid costly operator errors. The vision for the next generation of POS systems is to help make the terminal disappear, that is, to make the technology invisible to the user. Thus unencumbered from the mechanics of "computing," users can focus their energies at the task at hand: ringing up a sale at a POS.

To approach this vision, NCR developed an adaptive expert prototype system for a department store POS operation. An adaptive expert system uses technology that includes models of domain knowledge, operator knowledge, expert knowledge, and media presentation knowledge. These knowledge domains are employed in providing embedded training and intelligent, on-line help to the operator of the retail POS terminal.

The structure for the adaptive system called Retail User Assistant (RUA) was a software platform that performs the following activities in real-time:

> Observe operator's activities and interactions with the terminal hardware and software while performing the tasks at hand.
>
> Evaluate the operator's effectiveness in performing these activities against a model of "expert user" performance in the context of both the individual's and organizational rules and preferences.
>
> Communicate with the user to provide guidance and task training as needed and as permitted by the working environment.
>
> Adapt itself to compensate for changes in the user's level of knowledge and performance and to keep its communication with the user at an optimum.

In this project, NCR explored the use of text, graphics, and video to communicate to the POS operator. This paper discusses the development of the visual communication (user interface) for the adaptive expert prototype. First, the project process is explained. Second, the visual cue development decisions are discussed. Finally, the lessons learned from developing visual cues for a prototype system are presented.

PROJECT PROCESS

The prototype system consisted of an NCR 7052 POS terminal with a 2 X 20 operator display plus a 14 inch VGA monitor. The POS system ran the retail application software with the 2 X 20 display providing no more than 40 characters (alphanumeric) of feedback at any one time. The 14 inch VGA

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monitor displayed the adaptive expert messages to the user. These messages were retrieved from a videodisc. The adaptive expert application software monitored input from the retail application and then sent commands to the videodisc player indicating which segments to play. The messages displayed by the adaptive expert system combined text, graphics, and video to help the user perform the task.

To develop the visual cues for the adaptive expert system it was necessary to use a process that would drive the needs of the target users into the design and development of the prototype system. To accomplish this the designers followed a "User-Centered Design" process that greatly increases the chances of providing an effective and efficient communication channel with the user. User-Centered Design approach comes from a field called Human Factors Engineering, which combines analytical techniques with knowledge about humans and system design. It addresses the target users' perceptions of whether a system works well. A user asks, "Can I easily learn this system and then use it to perform my job efficiently?" These perceptions are the distinction between a functional communication system (2 X 20 display) as opposed to a usable communication system.

There are five phases in User-Centered Design process: Analysis, Concept Development, Prototype, Validation, and Implementation. These phases are briefly described below.

The *Analysis Phase* is essentially a data gathering phase. The developer collects information to gain an understanding of the targeted users and the nature of their work. The main objectives of this phase are to understand the user, task, and environment and the requirements of the POS system. The deliverables from this phase are task models, customer service models, system evaluations, and usability criteria.

The *Concept Development Phase* involves synthesizing the information collected in the analysis phase with the designer's knowledge of existing and emerging technology, human behavior, physiology, and psychology so as to develop solution strategies. The deliverables from this phase are concept documents, business models, and storyboards.

The *Prototype Phase* involves developing the completed storyboards into a working model. With a prototype the designer has a dynamic simulation of the system that can be used to gather informal user feedback. Iteration, a revision strategy, is extremely important in this phase, both for interaction style and instructional strategy. The deliverable from this phase is the "Look and Feel" of the proposed system.

The *Validation Phase* involves assessing whether the specified usability goals for the prototype have been achieved. The validation process involves following a formalized test plan using subjects who are typical users of the system. The deliverables from this phase is a design specification document and a revised prototype for the system developers.

The *Implementation Phase* involves using the design specification document and the revised prototype to bring the project to the product stage. Designers need to be integral part of the implementation team because many issues arise that are not addressed by the prototype specification document. The deliverable from this phase is the actual product.

There are two phases of the adaptive expert system that are discussed in this paper; the Analysis and the Concept Development. These two phases involved the conception and design for the prototype system. At the present time the Retail User Assistant project is in the final phase of prototyping and validation.

In the Analysis Phase, the objectives were to understand the user, task, and environment. The targeted users were department store sales associates. The designers first took the department store POS training course offered all new sales associates when they are hired. This step was important for several reasons. First, the designers learned the performance task and what tasks were difficult and easy to perform. The designers also became familiar with the instructional strategies used in the store training. Next, the designers observed the sales associates doing their jobs. Two methods were used. Cameras were set up and several days of videotape were shot for a detailed task analysis. Interviews of sales associates were conducted to gather demographic data, opinions of tasks' difficulty, and ideas on what information sales associates needed or wanted, but was not accessible on their present system. Also during observations, designers evaluated the work flow operation and the workstation design.

The in-depth analysis of the department store environment produced a user task model, the evaluation data on the current system, and the establishment of usability criteria. This phase took two months to complete. In product development, up-front analysis is extremely important. With this information, designers have a greater chance to design a product that will meet the needs of the user.

In the Concept Development Phase, the business model, visual display and instructional strategy were established. The business model stated the cost-justification of the expert system for a retail environment. The visual display and instructional strategy put an emphasis on the following:

- adapting information to the current needs of the user based on the terminal task and user request;
- utilizing various information delivery techniques including text, graphics and video.

One of the fundamental steps in designing an adaptive interface is determining what aspects of the system will change in response to changing conditions. In the Retail User Assistant, the primary method of adaptation was that of changing the information displayed. Another step in developing an adaptive interface is determining the condition that should cause the system to adapt. For example, the system might adapt to any of the following characteristics of the user, task, or environment:

- User experience with the task itself
- User previous experience (e.g., familiarity with GUI or command - line interface)
- User aptitudes (e.g., visual acuity or spatial reasoning ability)
- User preferences
- User demographic information
- Task complexity
- Task frequency
- Probable workload
- Physical conditions (e.g., adjusting the volume of audio messages according to the ambient noise level)

The RUA adapted to the user through recognizing the user's experience level, the task complexity, and task frequency. For each criterion used, there must be at least one source of data for the system. Data for the RUA was the user's experience level, an establishment of frequency/complexity ratings and the user's achievement on the system

recorded in real time (Meyers, Yachemovic, and Harris, 1992).

Once the strategy for expert adaptation was established, the storyboards for the user interface were developed. Storyboards are meant to serve as an early visualization of display screens and the interaction style for the user. Creating a storyboard is valuable because the designer can easily examine several different approaches in determining the most effective solution strategy.

Storyboards are paper for a reason; they can be redesigned easily. No design, especially design that involves understanding and designing for the needs and requirements of humans, is done right the first time. Storyboards are the first representation of the interface, and are meant to be modified.

Storyboards for the RUA project were sketched out for several types of information displays. Due to the volume of screens that had to be developed for the project, a small group of storyboards was used to establish the overall look and interaction style. After, final revision of the storyboards, the actual screen displays were developed.

VISUAL CUE DEVELOPMENT

The RUA information displays were developed for three levels of adaptation. The first level was established as preventive and was considered the basic interface for the user. If the sales associate was not committing any process errors on the terminal and was not a new hire (less than a month), they were shown screens from the first level. The second level was established as corrective. The sales associate viewed these screens only when the expert system detected a process error. For example, when a sales associate tried to apply a discount that was not appropriate, a corrective message would be displayed. The corrective message provided information to the user on what error was committed and how to correct the error. After the error was corrected the screen display would return to the first level. The third level was established as comprehensive help. The sales associate viewed these screens when they requested additional help or the expert system detected repetitive errors by the user in a particular transaction set. For example, a sales associate constantly made mistakes when processing a layaway sale. The level three screens provided more in-depth information and often used video to explain a process.

In the design of the visual cues for these three levels several issues were addressed. These included:

- What is the best visual format for combining text, graphics, and video?
- How can icons, symbols, and colors be used effectively?
- How can two informational displays be used effectively by the operator?
- Will changing levels in screen displays be confusing to the user?

Previous experience in designing screens for POS applications helped to clarify some of the visual cue issues. For example, text was viewed as the least desirable method for delivering information (Lewis, Miller, Waller, 1991). Users tend to ignore the text directions when graphics or still images are present (Miller, 1991). To maximize the benefit of both text and graphics, they were combined together to formulate sentences. For example, a direction would be

"Scan item's "

The text emphasized the action while the graphic displayed what they were to scan. To decrease unnecessary text, all articles in sentences were eliminated.

Icons were used as screen titles. In this way, users could quickly identify the type of transaction started. For example, a screen

with an open window icon meant the terminal was in the opening transaction, while a charge card icon meant that they were in a charge transaction.

Video was viewed as too time consuming for most transactions. Most customers would not want to wait while a sales associate viewed a 10 second video segment on how to complete a normal transaction. Therefore, video was used only when comprehensive help was needed. New associates often made mistakes inserting the various forms (charge, check) into the printer, therefore video was developed that showed how the forms were to be inserted.

Color was used effectively for text directions. Green text indicated a procedural step was appropriate. White text indicated only an explanation. In using green color for an appropriate or "GO" step, the designers took advantage of this color's accepted meaning in other real world areas.

Shape was also used as a visual cue. Solid arrows ▼ in front of text indicated both the beginning of a direction and an appropriate "GO" direction. This was in addition to the green color of the text. Solid blocks ■ in front of text meant these tasks were only appropriate if certain conditions existed.

From these few examples, it is easy to see that many rules existed for the visual cues. In this project there were over 200 screens created. To accelerate development and promote consistency, a set of visual cue rules were established. This proved very helpful as a communication tool among human factor designers and graphic designers. It also aided consistency in screen development that was accomplished in parallel. Rules established grammar, punctuation, font size and color, shape meaning and placement, icon size and placement, screen layout, and text and graphic placement. The rules were written and revised several times as the iterative design dictated.

LESSONS LEARNED

An emphasis in any good design should be on iteration. This project was no exception. The timing of iteration is crucial. For visual design of an interface, the storyboards should be taken to the users of the future system for their review. This was not done until after the storyboards had been turned into a functional prototype. Therefore, revision was more expensive.

The interaction and competition between the 2 X 20 display and the 14 inch display was an unknown before the usability testing. It was found that expert users often did not even notice the 14 inch display. Yet novices sometimes became confused when presented with different messages presented on the two screens. This area of two displays and how they can complement each other, instead of compete with each other, requires more analysis.

There was too much text on the screens. Users became confused because they were given so much information on what they could do, as opposed information on what was the most likely thing they wanted to do. For example, the most frequent task performed was a customer sale. Yet there was information on a refund, void, employee sale and layaway sale. This added confusion instead of clarification. Too much text on POS systems had been previously documented. (Miller, 1991). There also was too much information presented on the Level 1 preventive screens. At this level in the transaction set it was found that little assistance was required.

Color coding of the text proved to be a powerful delivery tool while the shape cue was lost to many of the users. The squares and blocks did not help users differentiate between types of directions.

In using icons, more user testing for recognition was needed. For example, an

upside down shopping bag was not easily detected as a label for store returns.

In conclusion, establishing a rule methodology for screen design proved very effective. It forced design decisions early, it proved valuable for consistency on screen layout among human factor designers and graphic designers. The rule document for screen layout has proven valuable in other projects.

Color and graphics proved very appealing to the user. Yet using a combination of both color and shape to differentiate tasks proved confusing.

As for an adaptive expert system for retail operations, the verdict is still out. One reason is that the cost per system is prohibitive. Yet the idea of providing information to the user when and where it is needed is extremely appealing.

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